Evaluation of a novel rodenticide: acute sub-lethal effects of a methaemoglobin-inducing agent

RJ Quy, TJ Gibson, MS Lambert, CT Eason and NG Gregory

1 Animal and Plant Health Agency, York, UK
2 Department of Production and Population Health, Royal Veterinary College, University of London, UK
3 Lincoln University and Connovation Research Ltd, Auckland, New Zealand
* Contact for correspondence and requests for reprints: tgbison@rvc.ac.uk

Abstract

In a series of experiments the welfare of para-aminovalerophenone (PAVP) sub-lethally poisoned rats (Rattus norvegicus) was assessed. The experiments: (i) examined the acute methaemoglobin (MetHb) profile over time; (ii) refined the LD50 estimate for PAVP in adult female rats; (iii) developed and validated three neurological tests; and (iv) assessed rats for neurological deficit following prolonged methaemoglobinaemia. The results from the first three experiments were used to refine the sub-lethal study. In the sub-lethal experiment 20 rats were gavaged with a single dose of 40 mg kg⁻¹ PAVP (based on an LD50 estimate of 43.3 mg kg⁻¹). Control rats (n = 10) were treated with the carrier only. Eleven (surviving) PAVP-treated rats and controls were assessed over a two-week period. Rats were tested for forelimb grip strength, stability on an inclined plane and the ability to remove tape wrapped around a forepaw in order to determine deficits in motor functions and sensorimotor integration. Signs of recovery began 3–6 h post-dosing, with all animals showing no outward signs of poisoning within 48 h, and over the 14-day post-treatment monitoring period they gained weight and increased their food consumption. There was no significant overall difference in performance between PAVP-treated and control rats in any of the three neurological tests. In the inclined plane test, performance of sub-lethally PAVP-poisoned rats appeared to be temporarily impaired with treated animals slipping at a lower angle than controls on day two. During the tape removal test, four PAVP-treated rats failed to remove the tape within the 3-min time limit on one occasion each (4/77 occasions) up to seven days post-dosing. The severity and duration of signs following acute sub-lethal PAVP poisoning appeared to be lower than those reported for existing rodenticides. It is likely that the results presented in this study extend to other MetHb-inducers.

Keywords: animal welfare, hypoxaemia, methaemoglobin (MetHb), methaemoglobinaemia, rat, sub-lethal

Introduction

Vertebrate pesticides are used to control pests, such as rats (Rattus spp), mice (Mus musculus) and other non-native animals in order to reduce damage to crops and property, prevent the spread of disease, reduce public nuisance and conserve native species. For rodent control, poison baiting is often preferred to other methods, such as trapping, on grounds of cost-effectiveness, but many of the poisons currently on the market are under frequent scrutiny due to concerns about humaneness and non-target effects. For example, the nature and duration of signs of poisoning and the time to death caused by anticoagulant poisons and the non-anticoagulant calciferol (cholecalciferol), have led to these pesticides being considered markedly inhume (PSD 1997; Littin et al 2002; Mason & Littin 2003; Fisher et al 2010). A commonly used alternative, zinc phosphate, kills quicker and thus could be considered relatively more humane (PSD 1997; Mason & Littin 2003; Ross & Henderson 2006; Eason et al 2013). However, the withdrawal of non-anticoagulant rodenticides, including zinc phosphate and calciferol, from some markets has led to even more reliance upon the use of anticoagulants. With the aim of improving humaneness and minimising the risk to non-target species without compromising efficacy, new bait formulations and novel vertebrate pesticides are being developed (Eason et al 2008).

One group of novel pesticides targets red blood cells in mammalian pests and induces the formation of methaemoglobin (MetHb), which at high concentrations leads to rapid and lethal hypoxia in the brain and heart, resulting in animals becoming lethargic and unconscious prior to death (Vandenbelt et al 1944). The potential of one particular MetHb-inducing chemical, para-aminompropionophenone (PAPP), as a vertebrate control agent has been investigated (Saverie et al 1983) and more recent research has demonstrated the efficacy of PAPP against non-native cats (felis catus silvestris), foxes (Vulpes spp) and stoats.